Influenza surveillance and immunisation in New Zealand, 1997–2006

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Background The national influenza surveillance in New Zealand is an essential public health component for assessing and implementing strategies to control influenza.

Objective The aim of this study is to report the national influenza surveillance data collected during 1997–2006 in terms of the community disease burden, circulating viral strains, hospitalisations, mortality, and immunisation coverage.

Methods The national influenza surveillance system includes sentinel general practice surveillance, laboratory-based surveillance, and hospital admission and mortality surveillance and immunisation coverage. The results obtained during 1997–2006 were analysed.

Results When the last 10 years were compared to the previous years, sentinel general practice surveillance recorded a decreasing

trend of influenza-like illness rates in the community. Sentinel surveillance also showed that children aged 0–4 years were the most affected. Influenza-related hospitalisation surveillance reported an increasing trend of hospital admissions particularly in children aged 0–19 years. Introduction of routine influenza vaccination among the New Zealand elderly was associated with a significant decrease of influenza-related mortality.

Conclusions This report demonstrates that an integrated virological and epidemiological surveillance system for influenza is essential for monitoring the disease burden, identifying circulating strains, guiding effective vaccination and planning for a potential pandemic.

Keywords: circulating viral strains, hospitalisations, immunisation coverage, influenza surveillance, influenza-like illness, mortality.

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Introduction

The national influenza surveillance system in New Zealand is an essential public health component for assessing and implementing strategies to control influenza because influenza can cause substantial morbidity and mortality in a short space of time. The purpose of influenza surveillance is to collect, collate, analyse and disseminate information on influenza activity that will assist in the assessment, prevention and control of the morbidity and mortality associated with the infection and its complications. The national influenza surveillance in New Zealand aims at monitoring incidence and distribution of influenza in the community, early detection of influenza epidemics and identifying the predominant circulating strains. The surveillance system includes sentinel general practice (GP) surveillance, laboratory-based surveillance, hospitalisations and mortality surveillance, and immunisation coverage surveillance.

Annual influenza immunisation is the primary method for reducing the impact of influenza in New Zealand. In 1997, the Ministry of Health made influenza vaccination available free to persons aged 65 years and older and in 1999, this policy was extended to risk groups less than 65 years.¹

This report summarises the community disease burden of influenza, the circulating influenza virus strains, hospitalisations, mortality and immunisation coverage during 1997–2006 in comparison with the previous years.²

Materials and methods

Sentinel GP surveillance

The sentinel GP surveillance system was established in 1991 as part of the World Health Organization (WHO) global programme for influenza surveillance. It is operated nationally by the Institute of Environmental Science and Research (ESR) and locally by surveillance coordinators within the

public health units in 24 health districts. The system operates in the winter usually from May to September each year. It is based on a network of volunteer sentinel GPs distributed on a population density basis of about 1 per 50 000, covering roughly 10% of the New Zealand population (Figure 1). Each sentinel practice records the daily number of consultations for influenza-like illness (ILI), along with the patient's age group, on a standardised reporting form. The case definition used for ILI is an acute respiratory tract infection characterised by an abrupt onset of at least two of the following: fever, chills, headache and myalgia. These data are collected by the local co-ordinator by email, phone or fax each Friday. The consultation rates were calculated using the sum of the patient populations,

reported by the participating practices, as the denominator. Because the age-specific patient population data were not provided by the participating practices, the denominator for the age-specific ILI consultation rate calculation was based on the New Zealand census data with the assumption that age distribution of the GP patient population was similar to that of as the New Zealand population. In addition, each sentinel practice also collects three respiratory samples (nasopharyngeal or throat swab) from the first patient seen with an ILI on Monday, Tuesday and Wednesday of each week. These samples are forwarded to the WHO National Influenza Centre (NIC) at ESR or one of three hospital laboratories in Auckland, Waikato and Christchurch for virus isolation and identification. The criteria for a laboratory

Figure 1. Percentage of population covered by sentinel general practice in New Zealand in 2006.

identification of influenza are the isolation of the virus or the direct detection of viral antigen. Influenza isolates are typed as being types A and B and influenza A isolates are further subtyped as being AH1 and AH3. An average of 1001 respiratory samples was received from sentinel surveillance annually with an average of 26% of ILI cases being confirmed as influenza during 1997–2006. The virus isolation data are forwarded by hospital laboratories to ESR each Monday. ESR reports the national information on epidemiological and virological surveillance of influenza weekly, monthly and annually to relevant national and international levels including the WHO Flunet (see <http://www.surv.esr.cri.nz/virology/virology.php>).

Laboratory surveillance

The NIC at ESR (previously the National Health Institute) was designated by the New Zealand Ministry of Health and recognised by the WHO in 1954. Since that time, the NIC at ESR has served as a key point of contact for both the WHO and Ministry of Health regarding virological and epidemiological surveillance of influenza, as well as the provision of influenza virus isolates to the WHO Global Influenza Surveillance Network (GISN).

The NIC and the three hospital laboratories at Auckland, Waikato and Christchurch form a laboratory network. The NIC collates all-year-round laboratory testing information on influenza nationally from mainly hospital inpatients and outpatients. This laboratory network conducts strain surveillance (initial typing and sub-typing) for influenza from the respiratory specimens collected from sentinel GPs and non-sentinel (hospital) clinicians. The majority of influenza viruses are forwarded to the WHO Collaborating Centre in Melbourne for further characterisation.

Hospitalisations

Hospital admission data for influenza [International Classification of Diseases, ninth revision (subsequently changed to 10th revision), Clinical Modification, ICD-9CM 487 or ICD-10AM J10-J11] from the New Zealand Health Information Service's National Minimum Dataset (NMDS) form the basis of influenza hospitalisation surveillance. Influenza-related hospitalisations were conservatively taken to include only those where influenza was the principal diagnosis.

Mortality

Deaths from influenza (ICD-9CM 487 or ICD-10AM J10-J11) from the NMDS constitute influenza mortality surveillance. These mortality data were only available up to 2003.

Immunisation coverage

In 1997, influenza vaccination was made available free to those 65+ years and in 1999 free vaccination was extended

to risk groups less than 65 years. The numerator for the vaccine uptake rate was based on claims that medical practitioners provide to Health Benefits Limited for reimbursement for these two groups. The denominator for the vaccine uptake rate was based on the New Zealand census data for intervening years.

Statistical analyses

Poisson regression analysis was performed for trend over the years for ILI consultation rates, isolates and hospitalisations by using Statistical Analysis Software (SAS) system version 9.1. There were no adjustments made in the regression analysis. The chi-squared test was performed for comparing the average hospitalisation and mortality rates between two periods by using Microsoft Excel.

Results

Sentinel GP surveillance

The national weekly ILI consultation rates for 1997–2006 in comparison with 1992–1996 are shown in Figure 2(A). The annual cumulative incidence rates of ILI consultations from 1997 to 2006 were 3124, 1327, 2354, 697, 1331, 929, 1234, 941, 1260 and 995 per 100 000 respectively. During 1997–2006, the average annual cumulative incidence of ILI consultation for the winter period was 1419 per 100 000. This was lower than 2931 per 100 000 during 1992–1996. The average peak weekly rate for 1997–2006 was 142 per 100 000, lower than 308 per 100 000 for 1992–1996. During 1992–2006, the ILI consultation rates showed a statistically significant decrease in the trend (Poisson regression analysis, $P < 0.0001$).

Rates of consultations for ILI from sentinel surveillance were calculated for each age group. During 1997–2006, the average weekly ILI consultation rates in children <1, 1–4 years, 5–19 years were 117, 122 and 69 per 100 000 respectively. This was lower than 341, 275 and 134 per 100 000, respectively, for the same age groups during 1992–1996. For some historical reasons, the ILI consultation rates for the elderly population were not consistent. The ILI consultation rate for persons 60+ years was provided during 1992–1999, whereas the ILI consultation rate for persons 65+ years was provided during 2000–2006. The average weekly ILI consultation rates for persons in 60+ years were 87 and 47 per 100 000 during 1992–1996 and 1997–1999 respectively. During 2000–2006, the average weekly ILI consultation rate for persons in 65+ years was 19 per 100 000. The average weekly ILI consultation rates for persons 20–59 years were 127 and 91 per 100 000 during 1992–1996 and 1997–1999 respectively. The average weekly ILI consultation rate for persons 20–64 was 45 per 100 000 during 2000–2006.

Figure 2. National influenza surveillance data.

Laboratory surveillance

Figure 2(B) shows the predominant types and subtypes of influenza viruses during 1990–2006. These isolates include those collected from mainly hospital inpatients and outpatients and those collected through the sentinel GP system. The average annual isolates were 718 for 1997–2006, higher than 431 for 1990–1996. The sentinel isolates remained at a constant level while non-sentinel (hospital) isolates showed a statistically significant increase in the trend from 1997 to 2006 (Poisson regression analysis, $P < 0.0001$). Since 2003, rapid antigen detection of influenza has been introduced in some hospital laboratories. The average annual influenza A viruses were 540 during 1997–2006, higher than 322 during 1990–1996. The average influenza B viruses were 174 during 1997–2006, higher than 109 during 1990–1996.

- Influenza AH3N2 predominated for six seasons in 1998, 1999, 2002, 2003, 2004 and 2006. A/Fujian/411/02 (H3N2)-like strain predominated in 2003 with the highest recorded hospitalisations.
- Influenza AH1N1 predominated in two seasons in 2000 and 2001.
- Influenza B predominated in two seasons in 1997 and 2005. B/HongKong/330/2001-like strain predominated in 2005 and the disease burden was high in children aged 5–19 years.³

- The predominant strain was the same between sentinel and hospital surveillance for 7 of 10 influenza seasons during 1997–2006. When two strains with similar proportions co-circulated during 1997, 1998, 2000, influenza AH3N2 was the predominant strain from hospital surveillance whereas the other strain (B or AH1N1) was the predominant strain from sentinel surveillance.

Hospitalisations

During 1990–2006, the overall influenza hospitalisations showed a statistically significant increase in the trend (Poisson regression analysis, $P < 0.0001$) (Figure 2C). A total of 4087 influenza hospitalisations were recorded during 1997–2006. The average annual hospitalisation rate for influenza was 10.4 per 100 000 during 1997–2006, higher than 6.5 per 100 000 during 1990–1996. The first and second highest hospitalisations were 580 in 2003 and 518 in 1999 – both years predominated by influenza AH3N2.

When average hospitalisation rates among different age groups were compared for the two periods (1997–2006 versus 1990–1996), it was noted that children aged <1, 1–4 and 5–19 years had a statistically significant increase of the average hospitalisation rate for 1997–2006 compared to that of 1990–1996 (chi-squared test, $P < 0.0001$) (Figure 3).

Figure 3. Comparison of influenza hospitalisation rates by age group.

Figure 4. Comparison of influenza mortality rates by age group.

The average hospitalisation rate among persons 65+ years did not show a statistically significant difference between the two periods.

Mortality

The influenza mortality data were compared between 1997–2003 and 1990–1996 (Figure 2D). There were 82 influenza fatalities recorded for 1997–2003 (an average annual rate of 0.3 per 100 000), lower than that of 284 for 1990–1996 (an average annual rate of 1.1 per 100 000). In other words, influenza-related mortality was reduced by 71% (202/284) during 1997–2003 compared with 1990–1996 (chi-squared test, $P < 0.0001$). During 1997–2006, the highest number of deaths caused by influenza was 27 in 1999 when influenza A/Sydney/5/97 (H3N2)-like viruses predominated. During 1990–2003, the average annual death rate was markedly higher in those aged 65+ years (5.8 per 100 000) compared with those aged 0–64 years, counting for the majority of deaths (94%, 343/366). When average mortality rates among different age groups were compared for the two periods (1997–2003 versus 1990–1996), it was

noted that persons aged 65+ years had statistically significant decrease in influenza mortality rate (2.27/100 000) during 1997–2003 compared with the rate (9.38/100 000) of 1990–1996 (chi-squared test, $P < 0.0001$) (Figure 4).

Immunisation coverage

Figure 2(D) shows influenza vaccine uptake for 1997–2006 in comparison with 1990–1996. The average annual vaccine update was 156 doses per 1000 during 1997–2006, three times higher than 50 doses per 1000 during 1990–1996.

Since 1997, when immunisation benefit claim data became available, influenza immunisation rates among those aged 65+ years increased – 39% in 1997, 55% in 1999 and 62% in 2002.⁴

Discussion

During 1997–2006, sentinel GP surveillance recorded about 1.4% of the population seeking ILI consultations and children aged <1 and 1–4 years were the most affected. During 1992–2006, there was a gradual downward trend of ILI

consultation, interspersed with winters of heightened activity. A reducing trend of ILI in the community was also observed through the GP surveillance conducted in England and Wales during 1966–2006.⁵ Elliot and Fleming speculated that this may reflect the declining ability of influenza virus to efficiently infect susceptible hosts. Factors influencing this might include mutational changes to the virus structure forced by decades of immunological pressure from the population.⁵

Optimal vaccine efficacy is dependent upon achieving a close antigenic match between the vaccine and circulating strains. Achieving this close match is possible through the WHO GISN. New Zealand has been an active participant of GISN since 1954. As a result, some influenza isolates such as A/Wellington/1/2004 have been selected as vaccine strains in the past. The head of the WHO NIC participates and contributes in influenza vaccine recommendations for the Southern Hemisphere as a member of the Australia Influenza Vaccine Committee.

Influenza hospitalisation surveillance recorded an average annual hospitalisation rate of 10.4 per 100 000 during 1997–2006, higher than 6.5 per 100 000 during 1990–1996. In contrast to the sentinel GP surveillance, influenza hospitalisation surveillance recorded an increasing trend of influenza hospitalisations during 1990–2006. Further analysis is required to understand whether the increase in hospitalisations is likely due to improvements in coding, improvements in sensitivity of diagnostic tests, more specimens being tested due to changes in hospital diagnostic practice, possible access problems in primary care, changes in admission criteria, changing demographics, predominance of AH3N2 viruses in many recent influenza seasons and/or true rise in ILI.⁶ In addition, influenza hospitalisation surveillance indicated that children aged <1, 1–4 and 5–19 years had a statistically significant increase in average hospitalisation rates during 1997–2006 compared to that of 1990–1996. High rates of hospitalisations among young children have also been reported in the United States.^{7,8} New measures to prevent influenza-related hospitalisations among young children are needed.

Influenza mortality surveillance recorded an average annual mortality rate of 0.3 per 100 000 during 1997–2003, significantly lower than 1.1 per 100 000 during 1990–1996. ICD-coded influenza deaths are useful for monitoring year-to-year trends and variability in the severity of influenza. However, they often underestimate the total burden of influenza because many deaths are caused by other secondary complications of influenza.⁷ Mills *et al.* assessed the aggregate burden of infectious disease in New Zealand in terms of mortality during 1980–1998.⁶ They found that deaths attributable to infectious disease was stable or declined slightly during 1980–1996, with a further fall from 1996, almost all of which was due to a fall in mortality

from infectious respiratory diseases. This fall could be an artefact of changes in coding practice in response to the New Zealand Health Information Service's 'Guide to writing Death Certificates'. This might have resulted in an increase in classifying chronic diseases as the primary cause of death and a reduction in pneumonias and 'ill-defined' causes. However, a true decrease in influenza mortality since 1997 cannot be excluded. Further studies including modelling are required to provide a more accurate estimation of the burden of influenza on mortality in New Zealand.

Introduction of routine influenza vaccination among the New Zealand elderly was associated with a significant decrease of influenza mortality. A statistical association cannot be taken as proof of cause and we cannot make claim that the policy changes resulting in greater uptake of the influenza vaccine are directly responsible for the decrease in mortality. However, the observed inverse relationship gives some justifications for us to speculate that this might be so. Further studies on the effectiveness of the vaccine are needed to understand the extent of beneficial effects of vaccination in New Zealand. The effectiveness of influenza vaccination in reducing influenza-related mortality in the elderly is currently under debate.^{8,9} Influenza vaccination has been reported to be highly effective at reducing influenza-related mortality in elderly people,^{10–12} although Simonsen *et al.* reported no improvement of influenza-related mortality in elderly people in the United States despite increasing influenza vaccination coverage.¹³ Despite the current scientific debate, people aged 65 years and older should continue to get influenza vaccination every year as the burden of influenza in this group is high and even modest protection for severe outcomes is certainly better than none at all.

In summary, this report compares the main influenza surveillance data sources for the last 10 years with the previous years. The impact of influenza in New Zealand over the past 10 influenza seasons has been substantial in terms of GP consultations, hospitalisations and deaths. This report demonstrates that an integrated virological and epidemiological surveillance system for influenza is essential for monitoring the disease burden, identifying circulating strains, guiding effective vaccination and planning for a potential pandemic.

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